Patent Claims

1. A device for controlling the drawing process in a transfer press, with two tool parts which act in opposition to one another and between which a workpiece to be deformed is held and of which one tool part, in particular a negative mold, can be moved between two reversal points, of which the first is assigned to the commencement of a work cycle, by a mechanical crank mechanism driven at a constant rotational speed, and of which the second tool part, in particular a drawing cushion, is connected via a piston rod to the piston of a hydraulic differential cylinder, the movement of the piston being controlled by the supply of pressure medium into a first chamber and by the discharge of pressure medium out of a second chamber of the differential cylinder, and in which, during a first time segment which extends within a range delimited by the first and the second reversal point, the rod-side face of the piston is acted upon by a pressure which is sufficiently high to accelerate the second tool part in such a way that, when the first tool part and the second tool part impinge one onto the other, both tool parts move at virtually the same speed, and in which a controllable throttle arranged between a bottom-side chamber of the differential cylinder and a tank determines the pressure in the bottom-side chamber, **characterized by the fact** that, in a second time segment (Δt_3) which follows the first time

segment (Δt_2) and extends until the second reversal point (UT) is reached, the rod-side face (A_r) of the piston (16; 56) is acted upon by a second pressure (p_{sN}) which is lower than the pressure (p_{sH}) during the first time segment (Δt_2).

2. The device as claimed in claim 1, **characterized by the fact** that the rod-side face (A_r) of the piston (16; 56) is acted upon by the first pressure (p_{sH}) again in a third time segment ($\Delta t_4 + \Delta t_5$) of the work cycle, which third time segment commences with the reversal in the direction of movement of the crank mechanism (13) and ends at the latest at the time point (t_6) in which the crank mechanism (13) reaches the first reversal point (OT).

3. The device as claimed in claim 1, **characterized by the fact** that the rod-side face (A_r) of the piston (16; 56) is acted upon, further, by the second pressure (p_{sN}) in a third time segment ($\Delta t_4 + \Delta t_5$) of the work cycle, which third time segment commences with the reversal in the direction of movement of said piston and ends at the latest at the time point (t_6) at which the crank mechanism (13) reaches the first reversal point (OT).

4. The device as claimed in one of claims 1 to 3, **characterized by the fact** that two pressure accumulators (27, 31) are provided, of which one (27) is charged to the first pressure (p_{sH}) and the second (31) is charged to the second pressure (p_{sN}), and that the action of pressure medium upon the rod-side chamber (15s; 55s) at the differential cylinder

(15; 55) takes place from the same pressure accumulator (27, 31) which is charged to the pressure (p_{sH}, p_{sN}) provided for the respective time segment (Δt_2, Δt_3, $\Delta t_4 + \Delta t_5$).

5. The device as claimed in claim 4, **characterized by the fact** that the second pressure accumulator (31) is connected to the rod-side chamber (15s; 55s) of the differential cylinder (15; 55) via a nonreturn valve (39).

6. The device as claimed in claim 5, **characterized by the fact** that there is arranged, in the line (42; 53) leading to the bottom-side chamber (15b; $55b_a$) of the differential cylinder (15; 55), a proportional valve (35; 51) which serves as a controllable throttle and which controls the flow of pressure medium from one of the pressure accumulators (27, 31) to the bottom-side chamber (15b; $55b_a$) of the differential cylinder (15; 55) and from this chamber to the tank (26).

7. The device as claimed in one of claims 4 to 6, **characterized by the fact** that a first pump (25; 65) maintains the pressure (p_{sH}) in the first pressure accumulator (27), and that a second pump (30) maintains the pressure (p_{sN}) in the second pressure accumulator (31).

8. The device as claimed in claim 7, **characterized by the fact** that the pumps (25, 30) are fixed-displacement pumps, and that a pressure cutoff valve (28, 32) is arranged in each case between a pump (25, 30) and the corresponding pressure accumulator (27, 31).

9. The device as claimed in claim 7, **characterized by the fact** that the pumps (65) are variable-displacement pumps.

10. The device as claimed in one of claims 4 to 9, **characterized by the fact** that there is arranged between the first pressure accumulator (27) and the rod-side chamber (15s; 55s) of the differential cylinder (15; 55) a valve (36; 52) which controls the pressure medium flow and the outlet connection of which issues into the line (40, 41) leading from the nonreturn valve (39) to the rod-side chamber (15s; 55s).

11. The device as claimed in claim 10, **characterized by the fact** that the valve arranged between the first pressure accumulator (27) and the rod-side chamber (15s; 55s) of the differential cylinder (15; 55) is a switching valve (36).

12. The device as claimed in claim 10, **characterized by the fact** that the valve arranged between the first pressure accumulator (27) and the rod-side chamber (15s; 55s) of the differential cylinder (15; 55) is a proportional valve (52).

13. The device as claimed in claim 6, **characterized by the fact** that the bottom-side face of the piston (56) of the differential cylinder (55) is divided into two part faces (A_{ba}, A_{bi}) of different size, which are acted upon by pressures (p_{ba}, p_{bi}) of different magnitude, that the pressure (p_{ba}) which acts upon the larger part face (A_{ba}) is controlled by the proportional valve (51), and that the pressure (p_{bi}) which acts upon the smaller part face (A_{bi}) is controlled by

a hydraulic machine (70) controllable continuously from pump operation to motor operation.

14. The device as claimed in claim 13, **characterized by the fact** that the piston (56) of the differential cylinder (55) is provided with a bore (57), into which a piston (58) fixed with respect to the housing engages, and that the supply of pressure medium to the inner bottom-side chamber ($55b_i$) formed from the bore (57) and the piston (58) fixed with respect to the housing takes place via a duct (59) in the piston (58) fixed with respect to the housing.

15. The device as claimed in claim 13 or claim 14, **characterized by the fact** that an electric motor (62) drives the pumps (30, 65) and the hydraulic machine (70) via a common shaft (63, 66), and that a flywheel mask (64) is connected to the shaft (63).

16. The device as claimed in one of claims 13 to 15, **characterized by the fact** that the pressure (p_{bi}) which acts upon the smaller part face (A_{bi}) is controlled such that it is lower than the first pressure (p_{sH}) in the first time segment (Δt_2) and is equal to the second pressure (p_{sN}) in the second time segment (Δt_3).

17. The device as claimed in claim 16, **characterized by the fact** that the pressure (p_{bi}) which acts upon the smaller part face (A_{bi}) is controlled such that it is equal to the first pressure (p_{sH}) in the third time segment ($\Delta t_4 + \Delta t_5$).

18. The device as claimed in one of claims 13 to 17, **characterized by the fact** that the hydraulic machine (70) is controlled to tank conveyance between the reversal point (OT) assigned to the commencement (t_0) of the work cycle and the commencement (t_1) of the first time segment (Δt_2).

19. The device as claimed in claim 14 or one of the following claims, **characterized by the fact** that a further nonreturn valve (75) is arranged between the second pressure accumulator (31) and the line (73) leading from the hydraulic machine (70) to the inner bottom-side chamber ($55b_i$) of the differential cylinder (55).